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$k_B T \rightarrow$ describes gas behavior but works for solids/liquids too

For solids/liquids too
Particles moving / KE directly prop to Kelvin Temp

10.1 IM Forces

Ch 8/9 Intramolecular forces - Forces in molecule Bonds

Now we look @ Inter molecular forces - attraction B/w molecules

Dipole-Dipole

↳ Molecules w/ dipole moments attract one another

c) distance tries to ~~accept~~^{be close} but not too close

only 10% as strong as covalent bonds

H-bonding (strongest) - occurs when dipole w/ an atom that is e-neg and bonded to H



Strong Blevery polar bond

- H is so small that dipoles can get very close

Allows for high BP of light covalent hydrides

usually lightest member has lowest BP (Group 4A)

but others Hb and so BPT

Same inorganic molecule

London dispersion -

↳ nonpolar molecules / noble gas intermolecular forces

e⁻ always move so @ a given point can get

momentary nonsymmetrical e⁻ distribution.

↳ instantaneous dipole

which can then cause another to form - induced dipole

Compare to noble gas FL's

atoms w/ more e⁻ → polarizability

10.2 Liquid State

low compressibility, not rigid, high D
↳ many different props - ~~adhesive~~

IMF's → attract molecules in from surface (Fig 10.6)

So liquid has smallest SA possible - why liquids bead

Results in Surface tension - Resistance for liq to increase SA

Polar liquids also have capillary action

↳ liq Rise up narrow tube of glass
SiO₂

2 forces adhesive → molec → glass

Cohesive → molec → molec

(conc)

Why can cave meniscus

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Viscosity too - resistance to flow

↳ glycerol, HC's (oil)

10.8 VP + State Change

liquids can vaporize (evap) - liq changing to gas @
Surface

opposite condensation



For H_2O $\Delta H_{\text{vap}} = 40.7 \frac{\text{kJ}}{\text{mol}}$ ← fairly high

evap / cond in equilibrium

See graph 10.39 show that evap same Rate + Condens needs
to catch up.

P @ Equilibrium → Equilibrium Vapor P.

Fig 10.40 How VP measured → Larger IM Forces
Lower VP

$$P_{\text{atm}} = P_{\text{vap}} + P_{\text{Hg}}$$

VP increases w/ temp 10.41

↳ higher T more molecules have min KE needed to enter gas state

Table 10.8 VP H₂O w/ Temp.

Fig 10.42 a → shows VP vs Temp @ 760 what happens?

10.42 b get straight line by graphing

$\ln(P_{\text{vap}})$ vs $\frac{1}{T}$

$$\text{eqn for line} = \ln(P_{\text{vap}}) = \frac{-\Delta H}{R} \left(\frac{1}{T} \right) + C$$

$$\begin{array}{c} \uparrow \\ y \end{array} = m \times + b$$

R = universal gas const

$$= 8.3145 \frac{\text{J}}{\text{mol K}}$$

C = constant charac of liquid.

Do 10.5 on pg 461

w/ that Eqn we can cal ΔH_{vap} for liquids know P_{vap} @ different T 's (3)

or if we know ΔH_{vap} + P_{vap} @ T_1 find @ T_2

B/c C not dep @ Temp

$$\ln(P_{\text{vap}, T_1}) + \frac{\Delta H_{\text{vap}}}{RT_1} = C = \ln(P_{\text{vap}, T_2}) + \frac{\Delta H_{\text{vap}}}{RT_2}$$

$$\ln(P_{\text{vap}, T_1}) - \ln(P_{\text{vap}, T_2}) = \frac{\Delta H_{\text{vap}}}{RT_2} - \frac{\Delta H_{\text{vap}}}{RT_1}$$

$$\boxed{\ln \frac{P_{\text{vap}, T_1}}{P_{\text{vap}, T_2}} = \frac{\Delta H_{\text{vap}}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)}$$

Clausius Clapeyron
Eqn

Prob 10.6 pg 463

Solids also have VP \rightarrow Sublimation

Changes of State

Heating Curve

Explain E D's here ΔH_{fus} ΔH_{vap}

$$\Delta H_{\text{fus}} = 6.02 \text{ kJ/mol} \quad \Delta H_{\text{vap}} = 40.67 \text{ kJ/mol} \quad C_p(\text{H}_2\text{O}) = 2.03 \frac{\text{J}}{\text{g}^\circ\text{C}} \quad C_p(\text{ice}) = 1.84 \frac{\text{J}}{\text{g}^\circ\text{C}}$$

Calc the ΔH change for converting 1.00 mol ice

@ -25°C to vapor @ 125°C

MP def - T which liq + solid have ID VP

BP def - T which VP = atm P

10.45 How defined \rightarrow left part VP ~~not~~ liquid higher so it evaporates to reach Eq and is gone.

Right VP solid higher so it sublimates to reach Eq. liquid left.

middle both in Eq w/ vapor so both exist

Factors affecting Solubility

Structure \rightarrow Polarity

Vitamins \rightarrow some fat soluble ADEK (hydrophobic)

H₂O soluble B C (hydrophobic)

Can get stored in fat

↑ excreted b/c H₂O soluble

Pressure (Bars)

External $P \uparrow$ Solubility \uparrow

↑ Solubility ↑

Henry's law $C = kP$

↑ Concentration

constant of soln

Partial P of gas above soln

Concentrate

↑ true when no ~~intention~~^{rxn} of solvent + solute
like HCl

Temp for Aqueous soln

Solids see Sol curve

gases curve too

Soln VP

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VP has decreased for a ~~soln~~ soln

Fig 11.9 2 Beakers

H₂O will vap from left
But not from Right

actually the beaker will
fill up w/ more H₂O Bk

VP ↓

Fig 11.10 shows VP lowered by non volatile solute

Quantified by Raoult's Law

$$P_{\text{soln}} = X_{\text{solvent}} P_{\text{solvent}}^{\circ} \leftarrow y = mx + (b) = 0$$

For $\frac{1}{2}$ solute / $\frac{1}{2}$ solvent $X = 0.5$

$$P_{\text{soln}} = 0.5 P_{\text{solvent}}^{\circ}$$

↑
non volatile solute dilutes
the solvent

Q 11.5 pg 499 molec

11.6 pg 500 ionic

11.5 BP ↑ FP ↓

Colligative Props - depend on # of solute particles
not Identity

Show graph for BP + FP

BP = when VP = atm P liquid Boils

Solute lowers VP thus more E needed to Boil and BP ↑

~~VP~~

$$\Delta T_B = K_b m_{\text{solute}}$$

↑
molar BP constant

FP = lower VP also means that solids won't form

$$\Delta T_F = K_F m_{\text{solute}}$$

Calc 11.430 p 507

For ionic solutes factor in
Van't Hoff Factor!

Osmotic Pressure - uses semi permeable membranes

↳ allows solvent but not solutes to pass through

Osmosis - Flow of solvent in to soln through Semi permeable mem.

Osmotic P → exerted by pure solvent on solute
causes soln level to Rise

$$\Pi = MRT$$

Annotations for $\Pi = MRT$:

- Π (Osmotic Pressure) → Osm P in atm
- M (Molarity) → Molarity
- R (Gas Constant) → Gas Const
- T (Temperature) → 298 K

W/ Van't Hoff: $\Pi = iMRT$

11.11 Find molar mass

Uses Dialysis - membrane allows for passage of small solutes too
↳ weeds out waste particles

Iso tonic soln → same osmotic P

Salt / sugar protect b/c make hypertonic soln

Reverse Osmosis

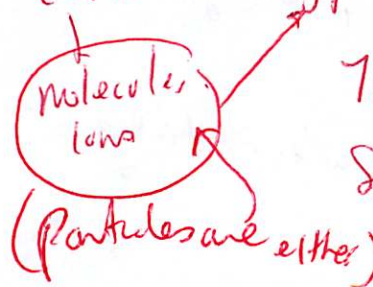
↳ ~~is~~ applied that is $\Pi_{\text{Soln}} \rightarrow$ pure solvent out

How it works in desalinization.

Colloids - suspension of tiny particles in some medium

↳ Distinguish via Tyndal Effect

electrostatic repulsion ^{of ions layers} keeps colloids suspended

Colloids aggregate ions from medium 2 layers
These repel other aggregates so they cannot settle + ~~settle~~ aggregate.

(particles are either)

particle in suspension attracts a layer of ions which attract another layer of ions from medium.